

## Analysis and Research on Distribution Network Scheduling Ground Fault

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**Abstract.** In accordance with the principles of handling accident, when the dispatchers handling ground fault, they should identify the situation, judge accurately, direct properly. Ground fault can be caused by a variety of reasons, such as single-phase ground fault of the line, the ferromagnetic resonance, voltage transformer fuse, etc. Single-phase ground fault in ungrounded system causes the voltage transformer saturation, causing ferromagnetic resonance. In that case, voltage transformer fuse can easily be burned and arrester explode. So the safety and stable operation of the power system is threatened seriously. Dispatchers must accurately analyze voltage phenomenon, judge accurately and deal with the fault.

**Keywords:** single-phase ground fault; ferromagnetic resonance; voltage transformer fuse; arrester explode

### 1. Introduction

Most distribution network are ungrounded system. When single-phase ground fault occurs, fault lines must be identified and removed as soon as possible. In actual operation, when ferromagnetic resonance occurs in ungrounded systems, it will appear zero sequence-voltage rising phenomenon for a long time. Also the system will appear higher amplitude zero-sequence voltage and zero-sequence current. The phenomenon is similar to single-phase ground fault. In this paper, after theoretical research focuses on the characteristics of fundamental ferromagnetic resonance failure, an identification theory based on a comprehensive comparison of the three-phase voltage is proposed through the comparison of ferromagnetic resonance, single-phase ground fault and voltage transformer fuse.

### 2. Single-Phase Ground Fault Analysis

There are about 80% single-phase ground fault in power system fault. When single-phase ground fault occurs, the voltage of small current grounding power system is still symmetrically. It does not affect the supply of electricity users.

As an example of metallic ground fault of phase C, three-phase voltage variation vector is shown in

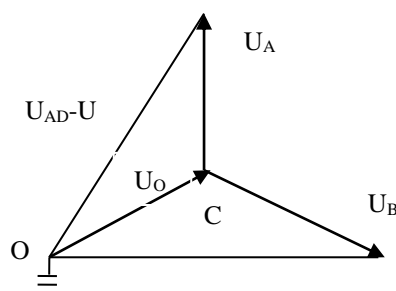


Fig.1. Three-phase voltage variation vector

Figure 1. It is easy to see the following characteristics between each vector relationship in Figure 1:

(1) The relative voltage of phase C is zero, i.e:  $U_{cd} = 0$

(2) The neutral point voltage is equal to the negative voltage of phase C, i. e:  $\dot{U}_{cd} = -\dot{U}_c$

(3) Ungrounded phase-to-ground voltage  $\dot{U}_{Ad}, \dot{U}_{Bd}$  are equal to the vector sum of its phase voltage  $\dot{U}_A, \dot{U}_B$  and neutral to ground voltage  $\dot{U}_{od} (-\dot{U}_c)$ . i.e:

$$\dot{U}_{AD} = \dot{U}_A + \dot{U}_{OD} = \dot{U}_A - \dot{U}_C = \dot{U}_{AC} = -\dot{U}_{CA}$$

$$\dot{U}_{BD} = \dot{U}_B + \dot{U}_{OD} = \dot{U}_B - \dot{U}_C = \dot{U}_{BA}$$

Thus, when the metallic ground fault of phase concurs, the ungrounded phase-to-ground voltage is elevated from the phase voltage of normal operation to the line voltage, increases  $\sqrt{3}$  times. The angle of the voltage vector  $\dot{U}_{Ad}, \dot{U}_{Bd}$  is 60 degrees.

(4) The magnitude and phase of three line voltage  $\dot{U}_{AB}, \dot{U}_{BC}, \dot{U}_{CA}$  do not change when single-phase ground fault occurs. They are still symmetric, i. e:  $\dot{U}_{AB} + \dot{U}_{BC} + \dot{U}_{CA} = 0$

### 3. The Reason Of Voltage Transformer Fuses

The internal coil of the voltage transformer occurs interterm, layers or phase to phase short circuit and a phase and ground phenomena, will cause the voltage transformer fuse. Voltage transformer, the first or secondary coil circuit fault, may cause over current voltage transformer. IF the secondary side of voltage transformer chooses the unreasonable capacity, may also cause the first side fuse. When the neutral point ungrounded system there is a ground, or because of the intermittent arc grounding may produce several overvoltage. Over voltage will cause serious saturated transformer, the current increase sharply and cause it to fuse. The ferromagnetic resonance of the system also generates a voltage transformer fuse. The overload operation or long term operation will lead fuse contact parts rust, then the poor contact will cause voltage transformer fuse.

### 4. The Mechanism Of Ferromagnetic Resonance By Voltage Transformer

The ferromagnetic resonance of the voltage transformer occurs in neutral ungrounded system. Ferromagnetic resonance of voltage transformer will cause it core saturation, then produce the saturation voltage. Any kind of Ferro resonance overvoltage produced to the system inductance, capacitance parameters have certain requirements, but also need certain conditions of excitation. The duration of overvoltage usually longer, even can exist stably, until the break resonance condition is satisfied.

There are two situations can make the ferromagnetic resonance of voltage transformer: the first, the power suddenly closes to the empty bus with only voltage transformer; the second, single-phase grounding. The above circumstances will appears inrush current greatly, make a primary side current of the voltage transformer increases several times, over voltage induced. Its harm severity depends on both the voltage size and the duration.

When the power supply suddenly closes to the empty bus only with voltage transformer, easy to produce the fundamental resonance (50HZ), for the performance of two phases to the increase of the voltage, the other decrease, or two decreases, the other rise; single-phase grounding is easy to produce frequency resonance (25HZ), its phenomenon is the voltage of three-phase to ground rises at the same time or take turns rises. The occurrence of high frequency resonance (100HZ, 150HZ), the voltage of three-phase to ground are increased, and the increasing great value more than the line voltage. According to these judgments, it produced a ferromagnetic resonance.

Its line voltage indicator unchanged when voltage transformer resonant occurs. Direct harm of voltage transformer resonant: due to great current through the first coil of the voltage transformer

when resonance occurs, the first fuse has not yet fused, may make the coil burning and cause the first fuse fused. Its indirect harm is that when the first fuse of the voltage transformer fused, will cause part of relay protection and automatic device have a false action so as to expand the accident.

## 5. Recognition And Processing

A phase or two phase voltage transformer high voltage safety fuse has given out ground signaling, but not according to its fusing relatively basic constant voltage characteristic, it can be distinguished from the single-phase earth fault. , it may be caused signal ground. When the voltage transformer high voltage safety fuse a phase or two phase (it often caused by ferromagnetic resonance).

Single-phase grounding handling: sub-network operation to reduce the scope, the sub-network system should be in scheduling under unified command, and consider of the relay protection in the power balance between the parts, mutual cooperation, whether arc suppression coil compensation degree is appropriate.

The sub-network that Operation is to bus section, narrow range, and find out there is still a grounded signal of a bus, step by step according to the rural power grid, public, dedicated line properties of push and pull.

Voltage transformer ferromagnetic resonance processing: when on the no-load busbar voltage transformer produces fundamental wave resonance, it should be immediately invest a backup device, changing the parameters of power grid, breaking the excitation conditions, and eliminating resonance. When a base single phase voltage transformer produces frequency resonance, should immediately invest a single phase load. Due to the frequency resonant with the nature of the zero sequence component, so often do not have a role in three-phase symmetrical load.

Voltage transformer fuse processing: a fuse fusing of voltage transformer caused by resonance, and resonance can eliminate itself. But may cause disoperation of relay protection and automatic device, this time should be quickly deal with the consequences of wrong action, such as check the stand-by power switch of union.

When resonance happens without causing a fuse fusing, should immediately stop using the loss of pressure easy disoperation of relay protection box automatic device. Bus bar has a standby power supply, switch to the standby power, to change the system parameters to eliminate harmonic; If using standby power resonance cannot eliminate, should pull open standby power switch, wait for bus power failure or after a fuse fusing resonance voltage transformer will be eliminated. Due to the resonance voltage transformer at a time when the coil current is very big, should be prohibited from opening voltage transformer isolation switch or go directly to the next side fuse method to eliminate the harmonic.

## 6. Conclusion

Single-phase grounding, voltage transformer fuse, transformer ferromagnetic resonance phenomenon similar to which closely linked, as the dispatcher must be on the phenomenon of the dispatcher understand from mechanism, analysis of the rise and fall of voltage, and make the correct judgment, to protect the safe operation of the power grid, improve power supply reliability.

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